Western Forest Insect Issues Study

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REPLY TO: 1440 Inspection

March 7, 1977

SUBJECT: Western Forest Insec

TO: Chief

Here is a copy of the final report on the Western Forest Insect Issues Study. This study was designed to give a broad overview of the forest insect situation in the western United States and to suggest some possible approaches to its solution.

This study showed that losses caused by forest insects, primarily bark beetles, are extensive and have been accruing over a long period of time. Because of the relatively low value of the insect-killed material and the relatively high costs of salvage, priorities for investment have been put in areas where returns are greatest. As a result, heavy losses are continuing and the productive capacity of the heavily impacted areas is declining. Since these areas will be required to meet the future demand for timber, they should be put back into production as soon as possible.

In addition to the large volumes of insect-killed material available for harvest, large areas of immature stands are also present. These stands will require silvicultural treatment to prevent recreating the conditions currently existing in the mature and over-mature stands and their subsequent decimation by forest insects. Since silvicultural treatments of this type frequently require large amounts of manpower, these operations could provide a significant number of jobs for the President's employment program.

If we're going to reduce losses caused by insects to tolerable levels, we must also utilize effectively all of the technology we now have available. As soon as funds and manpower permit, we should expand our research and development efforts to include a research, development, and application program for western bark beetles and the establishment, management, and protection of young stands.

The Study Team and I hope that this report will provide you with a sound basis for making future management decisions.

David E. Ketcham

DAVID E. KETCHAM
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WESTERN FOREST INSECT ISSUES STUDY REPORT

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EXECUTIVE SUMMARY

WESTERN FOREST INSECT ISSUES STUDY

Forest surveys show that over 2 billion cubic feet of growing stock are lost annually in the West to all natural causes. These losses approximate the annual harvest from the National Forests nationwide. Catastrophic outbreaks of forest insects, largely bark beetles, continue to be the major causes of timber mortality.

Recognizing the seriousness of the problem, the Chief appointed a team to design and conduct a Western Forest Insect Issues Study. The objectives of this study were to determine the nature and extent of the problem; develop alternative solutions or courses of action supported by economic data, funding requirements, and a general analysis of each course of action; recommend a research program to provide needed information for the management and protection of the forest resource; and suggest an action program for management and protection of the forest resource, including the harvesting of the insect-killed trees to the extent possible. This study was designed to provide a reconnaissance-level overview of the total forest insect situation in the West, utilizing currently available information.

The Study estimated at a total of 5.5 billion cubic feet of salvable sawtimber-size material had been killed by insects on lands of all ownerships, most of which were on the National Forests. The Study also identified about 1.9 million acres of over-dense, pole-size stands of lodgepole and ponderosa pines growing on good sites. These stands must receive the appropriate silvicultural treatment to prevent heavy future losses caused by bark beetles.

For the period from fiscal year 1978 through 1982 the Study Team recommended that the Forest Service accelerate its current programs to salvage insect-killed material in the lower-cost, more-productive areas; to provide the necessary silvicultural treatment to 1.9 million acres of pole-size lodgepole and ponderosa pine stands growing on good sites; and to emphasize the development and application of currently available technology.

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INTRODUCTION

According to *The Outlook for Timber in the United States*, over 2 billion cubic feet of growing stock are lost annually in the West to all natural causes. These losses approximate the annual harvest from the National Forests nationwide. Catastrophic outbreaks of of forest insects, largely bark beetles, continue to be the major causes of timber mortality.

Of the about 129 million acres classified as commercial timberland in the West, over one-half is in the National Forest System. Thousands of acres of existing stands of timber on the National Forests are overmature and highly susceptible to attack by insects. One reason for this is that the National Forests are generally located on the higher, more remote, and inaccessible areas. In general, the more accessible lands, most of which are in private ownership, were logged first. Timber sales on the National Forests did not reach significant levels until the 1940's.

Timber management activities can play a major role in limiting loss caused by forest insects. Timely and appropriate silvicultural treatments can help maintain vigorous growing conditions and species mixtures which make stands less susceptible to damage. Prompt salvage of dead or dying trees minimizes the waste of valuable material, helps to avoid accumulation of unacceptable fuel levels, and may reduce insect populations.

On the National Forests decadent stands suffering high mortality are programmed for harvesting as early as possible. As a result, an increasing portion of the western National Forests is now in young, vigorous timber stands that will help to meet the future demand for wood products. Unfortunately, in many areas barriers or constraints limit the opportunities for creating new stands through the existing timber sales program. These constraints include, but are not limited to, the following:

-- Lack of access
-- Inadequate funding or staffing levels
-- Limited markets or manufacturing facilities
-- Inadequate technology
-- Possible adverse impacts on other resources
-- High logging costs and low stumpage values
-- Lack of land-use plans, environmental impact statements, etc.
-- Procedural or administrative constraints.

The *Renewable Resource Program*, which was developed in response to the Forest and Rangeland Renewable Resources Planning Act of 1974, states:

> Demand for softwood timber from domestic forests (after allowances for increased imports and improvements in utilization assuming constant 1970 prices) will rise from 8.8 billion cubic feet in 1970 to 18.4 billion cubic feet by 2020. The demand for sawtimber will rise from 46.2 to 79.7 billion board feet.

If the National Forests in the West are to contribute their share of forest resources for society's future needs, much of the area now being decimated by forest insects will have to be brought under management.

OBJECTIVES

As a result of a General Management Review of the Rocky Mountain Region and Station conducted in August 1975 which recognized the seriousness of the forest insect situation in the West, the Chief appointed a team to design and conduct the Western Forest Insect Issues Study. The objectives of this study were to:

- -- Determine the nature and extent of the problem
- -- Develop alternative solutions or courses of action supported by economic data, funding requirements, and a general analysis of each course of action
- -- Recommend a research program to provide needed information for the management and protection of the forest resource
- -- Suggest an action program for the management and protection of the forest resource, including the harvesting of the insect-killed trees to the extent possible.

This study was designed to provide a reconnaissance-level overview of the total forest insect situation in the West, utilizing currently available information. This study will provide the basis for future management direction to reduce losses caused by forest insects to tolerable levels.

NATURE AND EXTENT OF THE PROBLEM

In order to provide a general assessment of the nature and extent of the insect-pest-related damage, a survey utilizing only information already available from previous aerial and ground surveys, evaluations, and inventories was conducted throughout the Western United States, including Alaska. The survey provided broad data on:

-- Location of problem areas by Region and State
-- Landownership
-- Forest types
-- Insect group (bark beetles or defoliators) causing damage
-- Total inventory of forest types by acres; volume of sawtimber- and poletimber-size products; and by factors affecting management action such as accessibility, market conditions, or availability
-- Salvable dead trees in the same categories as above
-- Amount threatened in calendar year 1976 in the same categories as above
-- Amount salvaged in calendar year 1975 in terms of acres and volume of sawtimber-poletimber product sizes.

This survey estimated that a total of 5.5 billion cubic feet of salvable sawtimber-size material had been killed by insects on lands of all ownerships. Salvable[1] volume (billion cubic feet)[2] of sawtimber-size trees killed by forest insects, by ownership in the West,[3] is as follows:

Ownership	Accessible[4]	Inaccessible[5]	Unavailable[6]	Total
National Forest	1.2	2.4	1.1	4.7
Other Federal	0.1	0.2	-	0.3
State and private	0.2	0.3	-	0.5
Total	1.5	2.9	1.1	5.5

Of this amount about 4.7 billion cubic feet or 85 percent were on National Forest lands. Of the remainder 10 percent was on State and private lands and 5 percent on other Federal lands. Of the 5.5 billion cubic-foot total about 1.5 billion cubic feet were in areas having adequate access; 2.9 billion cubic feet were in areas having inadequate or no access; and the remaining 1.1 billion cubic feet were in areas where salvage, harvest, or timber stand improvement was prohibited by regulation, law, or administrative designation.

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[1]Standing or down dead trees considered merchantable by Regional standards.

[2]To convert cubic feet to board feet, multiply number of cubic feet by 5.

[3]Areas surveyed included Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming.

[4]Areas which can be reached by existing roads.

[5]Areas requiring roads to be built, including inventoried roadless areas not selected for wilderness study.

[6]Areas where salvage, harvest, or timber stand improvement is prohibited by regulation, law, or administrative designation.

Of the 5.5 billion cubic feet of insect-killed timber identified, only 2.7 billion cubic feet were in areas having markets (table 1).

Table 1.--Salvable volume (billion cubic feet) of sawtimber-size trees killed by forest insects by ownership, accessibility, and market status[1]

Ownership	Accessible		Inaccessible		Total
	w/markets	w/o markets	w/markets	w/o markets	
	billion cubic feet				
National Forest	0.9	0.3	1.1	2.4	4.7
Other Federal	0.1	-	0.2	-	0.3
State and private	0.2	0.1	0.2	-	0.5
Total	1.2	0.4	1.5	2.4	5.5

[1]Includes areas where salvage, harvest, or timber stand improvement is prohibited by regulation, law, or administrative designation.

Studies also showed that the forest types most heavily impacted by forest insects were spruce-fir, lodgepole pine, and Douglas-fir. Other types showing significant loss were western white pine and ponderosa pine. Salvable volumes, in billion cubic feet, are:

Forest type	Volume
Spruce-fir	2.1
Lodgepole pine	1.8
Douglas-fir	0.8
Western white pine	0.3
Ponderosa pine	0.2
All others	0.3
Total	5.5

The primary insects causing losses were the spruce beetle (*Dendroctonus rufipennis*), mountain pine beetle (*Dendroctonus ponderosae*), Douglas-fir beetle (*Dendroctonus pseudotsugae*), the western spruce budworm (*Choristoneura occidentalis*), and the Douglas-fir tussock moth (*Orgyia pseudotsugata*).

MANAGEMENT SITUATION

Mature Stands

The damage survey showed that most of the insect-caused losses occurring in the West were in mature or overmature stands. Using this information as a basis, we gathered the economic data necessary to analyze opportunities for harvesting the dead trees (or stands). These included:

-- Identifying problem areas having salvage opportunities
-- Determining the major constraints to salvage action
-- Estimating cost, in terms of manpower and dollars, required to remove these constraints
-- Determining the additional volume of timber that could be made available by the removal of these constraints
-- Estimating the cost of doing nothing, in terms of impact on other resources and management opportunities lost.

This phase of the study identified 103 problem areas on National Forest lands in Forest Service Regions 1-6. Constraints to putting these areas under management and to salvaging the insect-killed material ranged from lack of funds and manpower to a need for land-use planning and additional technology.

Given adequate manpower and money to remove the constraints, the western Regions could begin to put 82 of the 103 problem areas identified under management by fiscal year 1982. These areas could yield about 1.1 billion cubic feet of insect-killed material at a cost of about $37 million and could provide 160 million cubic feet annually at a cost of $9.6 million by fiscal year 1982 (table 2).

Table 2.--Summary of salvage opportunities by cost and site productivity classes

	Lower cost, more productive areas	Higher cost, more productive areas	Higher cost, less productive areas	Total all areas
Annual program possible by FY 1982:				
Cost (million $)	5.0	1.1	3.5	9.6
Volume (million cubic feet)	127.9	8.9	23.1	159.9
Cost per thousand cubic feet ($)	39	123	152	60
Anticipated receipts (million $)	7.5	0.5	0.2	8.2
Removal of constraints required to permit annual program:				
Cost (million $)	13.6	12.2	11.5	37.2
Volume made available (million cubic feet)	385.0	45.0	692.5	1,122.5
Cost per thousand cubic feet ($)	35	271	17	33

However, much of this volume is in species having low value and growing on poor sites. Significant amounts of this volume are also located in currently inaccessible areas where the costs of road building and other activities are high. By eliminating many of the higher-cost, less-productive areas, about 385 million cubic feet could be made available at a cost of $13.6 million. This would make possible an annual program of about 128 million cubic feet at a cost of $5 million by fiscal year 1982. Anticipated receipts from this option would be about $7.5 million annually.

The costs of doing nothing are also real but are difficult to quantify from the information available. These include such things as increased cost of fire prevention and suppression in areas having high tree mortality, the loss of the volume killed, and the delay in the establishment of productive new stands. For example, untreated mountain pine beetle infestations will result in increased fire suppression expenditures in heavily infested areas. In a typical uninfested lodgepole pine stand with 1 percent fuel moisture, 20-to 40-percent slopes, and 30 mph winds, a wildfire start would burn 8.02 acres in 1 hour. Under the same conditions in a heavily infested stand, the fire size after 1 hour would be 32.3 acres, a 400-percent increase. Harvesting of dead and infested trees and sanitizing the area would lower fire-spread potential. The proportion of decreased fire suppression cost which would result from this treatment would vary by individual problem areas based upon physical site characteristics and the degree of infestation. Nontimber values, such as adverse impacts of severely damaged stands on certain species of wildlife and dispersed recreation use, are also included.

Before any management action is taken, every area selected should be visited on the ground by an appropriate, multidisciplinary team to prescribe the necessary management treatment, such as:

-- Regeneration to appropriate species, often to a species of a higher value or to one to lower susceptibility to pests than the species removed
-- Other silvicultural treatments
-- Fire suppression and fuel management.

These prescriptions should also include such things as possible impact on:

-- Threatened and endangered species
-- Allowable cut
-- Existing insect infestation
-- Other resources such as recreation, water, and wildlife habitat
-- Other insect and disease problems.

Because of the possible mixture of dead, infested, and green (uninfested) material contained in many stands, the optimum management treatment for many species would be clearcutting and regeneration to less susceptible species or mixtures. Thus, the cost of removing constraints and the annual program cost per thousand cubic feet would be lower than estimated because of the significant volumes of green material of higher value that would be removed with the dead material.

Another factor which must be considered in the making of management decisions is that, although some of the dead material can be converted to lumber, most of the volume is probably suitable only for fiber or fuel use. These areas are also relatively close to sources of comparatively lower cost fuel or energy, such as coal.

The outlook for new markets for large volumes of insect-killed timber within the next 5 years due to increased national and export demand seems unlikely. Also, because of the significant additions to the capacity of wood processing plants in the early 1970's, the rate of new plant construction over the next 5 years will likely be considerably below the levels of the past decade.

Immature Stands

Timely and appropriate silvicultural treatments designed to maintain vigorous growing conditions and species mixtures make stands less susceptible to damage by certain insects and diseases. Other management considerations that reduce potential for losses caused by insects include sanitation-salvage cuts, management by elevation zone and/or habitat type, and the establishment of appropriate rotation ages. Known management techniques to minimize losses caused by insects are not now being applied as widely as needed. This is especially true in the cases of lodgepole and ponderosa pines.

The Outlook for Timber in the United States estimates that National Forests and nonindustrial private lands contain about 5.9 and 2.3 million acres, respectively, of pole-size stands of lodgepole and ponderosa pines. To prevent large future losses caused by bark beetles, most of these acres would require treatment. Access, funds, and manpower are the major constraints to providing the necessary treatments. Because of the high costs of road construction and the appropriate silvicultural treatments, management efforts to prevent losses should be concentrated on the best sites.

Of the 5.9 million acres of lodgepole and ponderosa pine stands on National Forest lands, about 1.9 million acres are site classes II and III or better which produce 85 cubic feet or more per acre per year. Of the 2.3 million acres of nonindustrial private lands in these types, only 181,000 acres are on site classes II and III or better. For this reason an accelerated program should deal primarily with the problems on National Forest lands.

Investments in precommercial thinning of immature stands of lodgepole and ponderosa pines can provide reasonable returns, especially on the better sites. For example, investments in those species on sites capable of producing 120 cubic feet per acre per year should provide a rate of return of about 8.8 percent and have a benefit-cost ratio at 5 percent interest of 1.96. Rates of return and benefit-cost ratios for these stands by site productivity class can be summarized as:

Site productivity class (cubic feet per acre per year)	Rate of return on investment (percent)	Benefit/cost at 5 percent interest
120+	8.8	1.96
85-119	8.2	1.93
50-84	7.5	1.67
20-49	5.4	1.12

The precommercial thinning in immature stands of ponderosa pine in the Black Hills of South Dakota should produce similar returns. The rates of return and benefit-cost ratios for the ponderosa pine in the Black Hills of South Dakota can be summarized as:

Site productivity class (cubic feet per acre per year)	Rate of return on investment (percent)	Benefit/cost at 5 percent interest
120+	9.2	1.54
85-119	7.5	1.38
50-84	6.3	1.15
20-49	4.5	0.81

However, these analyses include the costs of treatment. They do not include the costs of gaining access to the areas, such as the construction of roads.

Assuming average costs of $40,000 per mile for minimum standard access roads and $80.00 per acre for the appropriate silvicultural treatments, an investment of $36 million per year would be required to complete treatment of the 1.9 million acres in a 10-year period. The following summarizes the costs and time required to complete silvicultural treatment of 1.9 million acres of lodgepole and ponderosa pine growing on good sites (producing 85 cubic feet or more per acre per year):

	Time required		
	10 years	20 years	30 years
Roads needed annually (miles)	520	260	175
Area treated annually (acres)	190,000	95,000	64,000
Annual costs (million dollars):			
Roads	20.8	10.4	7.0
Treatment	15.2	7.6	5.1
Total	36.0	18.0	12.1

This program could be increased or decreased depending on the availability of funds, but it should be given priority consideration if we are going to avoid recreating the conditions which exist today in our mature and overmature stands and their subsequent decimation by bark beetles. These costs would be significantly less in areas where the construction of roads was not required.

Each of these options would leave over 4 million acres of immature stands of lodgepole and ponderosa pines growing on poorer sites. Without proper treatment these stands will incur heavy future losses caused by bark beetles similar to those occurring now in overmature stands.

RESEARCH, DEVELOPMENT, AND APPLICATION

The Study Team was charged with assembling an array of options for research and development activities focused on western forest insect problems. The Team assessed the state-of-the-art of stand management to minimize risk of losses to bark beetles and defoliators in western forest types and identified gaps in knowledge for which additional research is needed.

For the nine western forest types examined, there is considerable knowledge of stand management practices likely to reduce losses to insects, particularly bark beetles. These practices are not widely applied, largely because of lack of markets and/or efficient harvesting technology, especially on sensitive forest sites. Further, these practices have not been fully evaluated so that costs and subsequent benefits can be reliably predicted. There is also considerable urgency for expanding and accelerating research on young stands--the stands of the future--so that pest problems as we know them today can be prevented or mitigated in the future.

Development and Application of Current Technology

One option is the development and application of current technology. This option would involve such things as pilot projects to evaluate insecticides and stand manipulation practices, development and implementation of damage survey and analysis technology,and the development and demonstration of harvesting and utilization methods.

Pilot projects to evaluate insecticides.--Insecticides are sometimes needed for suppression of insect outbreaks in high-value timber stands and for prevention of losses in seed production areas, nurseries, and high-use recreation areas. Materials registered for use against forest insects in other parts of the U.S. should be evaluated against western insects. Materials showing promise in field experiments require further evaluation at a pilot project level to more specifically determine the costs and benefits of suppression.

Pilot projects cost from $250,000 to $400,000 depending on the types of environmental data required to support registration. At least two pilot projects per year would be required in the West to provide insecticides with improved environmental safety characteristics, to extend existing labels to western applications, and to develop alternatives to currently registered materials.

Pilot projects to evaluate stand manipulation practices.--Outbreaks of of some forest insects, particularly bark beetles, are closely correlated with forest stand conditions. Management activities which improve or maintain vigorously growing stands may also help to prevent pest outbreaks. Although broad guidelines for silvicultural manipulation of basal area, species composition, site-species relationships, and length of rotation are available, they have not been tested sufficiently to recommend management strategies with high probability of success.

The costs and benefits of various stand management practices to reduce losses from bark beetles should be evaluated in lodgepole pine, ponderosa pine, and spruce-fir stands Westwide. One test would evaluate five harvest and thinning treatments, each on 40-acre blocks, for their effects on reducing losses caused by the mountain pine beetle in lodgepole pine stands. Replicates of the test could be installed in Regions 1, 2, and 4. The test could be installed in fiscal year 1977 at a cost of about $75,000 and evaluated in the succeeding 4 years at an annual cost of about $50,000.

Damage survey and analysis technology.--Forest resource management may be influenced significantly by pest-related damage--tree mortality and growth loss. Current technology does not provide the timely and reliable loss data required by forest managers to avoid disruption of management plans. Accelerated development efforts would provide land managers with damage survey techniques and analysis systems with which to determine losses, to identify alternative pest management strategies, and to calculate the cost-effectiveness of alternatives. Costs to accelerate development of damage survey and analysis technology are estimated at $500,000 per year.

Development and demonstration of harvesting and utilization technology.--Application of silvicultural measures to bring susceptible timber stands under management and prevent future insect depredations requires systems for access and harvesting that minimize environmental impact. Salvage and utilization of insect-damaged timber depend on technology that minimizes damage to the environment and reduces costs. Such timber is typically remote from normal processing centers, frequently small in size, and of limited use because of the decay, checks, and splits.

Harvesting equipment that uses a long cable reach instead of a closely spaced network of roads is currently available and in use for large, high-value timber. Equipment which has demonstrated technical and economic feasibility for small, lower-value timber is required. New cable logging systems offer considerable promise for fulfilling this harvesting technology gap. Further development, field testing, and demonstration are needed to verify the utility of equipment such as the Pee Wee Yarder and the long-reach cable system to loggers.

Initial costs for evaluating the equipment would be $500,000 in fiscal year 1977 and $525,000 in fiscal year 1978. Annual costs for evaluating and demonstrating the equipment would average $600,000 in succeeding years. A similar 5-year program to evaluate, demonstrate, and implement the long-reach cable system would cost about the same.

Research, Development, and Application Program for Western Bark Beetles

Another option is a research, development, and application program for western bark beetles. We have much basic knowledge of bark beetle biologies and few control techniques, and we lack fully evaluated management systems which integrate pest control strategies with forest management practices. The needed technology can be provided by a coordinated Westwide program of research and development. Major Forest Service participants would be Timber Management Research, Forest Insect and Disease Research, Forest Insect and Disease Management, and Regions 1-6. Other Forest Service, State, and university units would also be included.

A fully funded Westwide program on bark beetles would evaluate, refine, and implement techniques to predict the effects of mortality on stand growth and development; develop new and improved systems for evaluating social and economic impacts; develop treatment technologies compatible with forest uses for reducing mortality; and develop forest management alternatives for minimizing impacts on forest resources. Development of harvesting systems that economically remove dead or threatened trees or parts of trees and utilization technologies that convert dead trees or whole green trees into useful products would be included in the program. Special studies would evaluate the impact of adding substantial volumes of dead timber to established conventional markets and the potential for industrial development opportunities for the dead timber. Other major efforts would develop and evaluate various approaches to bark beetle control--such as attractants, repellents, protective toxicants--with special emphasis on stand treatments. A framework combining safe and effective control methods with forest management practices would be devised by simulation techniques using beetle-population dynamics, stand dynamics, and yield models. This program

would focus on the mountain pine beetle in lodgepole pine and ponderosa pine stands on the most productive sites and direct some attention to the western pine beetle and Douglas-fir beetle.

The ultimate program output would be management alternatives by which forest managers could minimize losses to the major western bark beetles. This would also result in reduced fire hazard. Within 5 years substantial progress could be made toward providing the technology to integrate pest control and reduce management strategies.

Average annual costs (Research and S&PF) of the proposed RD&A program on the mountain pine beetle and other western bark beetles would be about $4.5 million.

All research and development activities in the development and application option specifically related to western bark beetles would be included in the proposed RD&A program.

Expanded Research, Development, and Application

A third option is an expanded research, development, and application program. This option would include those activities described in the above two options. These options would be expanded to include research on the establishment, management, and protection of young stands on the most productive sites.

Insect outbreaks, especially those resulting in extensive tree mortality and subsequent salvage logging, disrupt natural regeneration and development of host stands. Lands of high timber-producing potential should be quickly restored to full timber production. Improved methods are needed for increasing survival and growth of planted or seeded trees.

Research recommended on regeneration and establishment would improve seed handling, nursery culture, and planting practices (including accelerated development of containerization) for selected western conifer species; develop better methods (including more extensive use of mycorrhizal associations) for reestablishing trees on western mountain sites; and develop safe and effective biological and chemical methods to reduce insect, disease, and animal damage to seed, seedlings, or planted conifers.

The research on management of young stands would intensify thinning research in natural stands of selected Rocky Mountain conifers established following insect outbreaks; develop new methods or techniques for area-wide timber stand improvement; and accelerate research on selective herbicides and fertilizer treatments to increase vigor and growth in young stands; and biological control systems for removing inferior trees to improve composition, vigor, and growth of young stands.

This research would strengthen the scientific base for new nursery and greenhouse programs urgently needed for most conifers in the West; improve planting and seeding techniques which can be quickly implemented by all landowners, even where intensive forest management is not practical; and increase per-acre yields of important western types from 5 to 100 percent by increasing seedling survival rates and maintaining vigorous, fully stocked stands that are less susceptible to insect outbreaks.

Increased funding for this program is $800,000 annually. This is in addition to the $4.5 million needed for the research, development, and application program for western bark beetles.

Analysis of Options

All three options would provide problem-related technology to reduce insect-caused losses to tolerable levels (table 3).

Table 3.--Summary of research, development, and application options and anticipated contributions to problem-related technology

	Objective		
Option and activity	Remove accumulated volume of dead timber	Suppress current insect outbreaks	Prevent future insect outbreaks
Development and application of current technology			
Pilot projects of insecticides	none	moderate	moderate
Pilot projects of stand manipulation	none	none	high
Pest damage assessment techniques	low	low	low
Harvesting, utilization technology	high	moderate	high
Research, development, and application program on western bark beetles			
RD&A Program on western bark beetles	high	moderate	high
Expanded research, development, application			
RD&A Program on western bark beetles	high	moderate	high
Establishment, management, protection of young stands	none	none	moderate

The option providing for the development and application of current technology would be the least expensive. It would provide high returns on the investment in terms of the salvage of insect-killed material, suppression of current outbreaks, and prevention of future outbreaks. The average annual costs for the three options for research, development, and application are:

Option	Average annual cost (millions)
Development and application of current technology	$2.0
Research, development, and application program for western bark beetles	$4.5
Research, development, and application program expanded to include establishment, management, and protection of young stands	$5.3

However, if we're to meet our future goals of timber production as required in the Resources Planning Act, we must have the technology described in the expanded research, development, and application option relatively soon.

RECOMMENDED PROGRAM

The Study Team developed and studied the many possible options to harvest millions of cubic feet of insect-killed timber, provide for the future management of immature forest stands in the West, minimize intolerable losses caused by forest insects, and develop technology needed for forest management and protection.

The results of the study have been reviewed by and discussed with interested national conservation and forestry organizations, Regional Foresters and Station Directors in the West, Washington Office Staff Units, and Chief and Staff.

Based on these reviews, discussions, and comments the Study Team recommends the following programs.

Mature Stands

For the period from fiscal year 1978 through 1982 the Study Team recommends that the Forest Service accelerate its current salvage program to capture insect-killed material in the lower-cost, more-productive areas identified in the study (table 2). This program would provide for the removal of the constraints on about 385 million cubic feet of insect-killed material at a total cost of $13.6 million over the 5-year period. This would result in an annual program

ranging from the removal of 93.9 million cubic feet worth $6.0 million at a cost of $9.7 million in fiscal year 1978 to the removal of 127.8 million cubic feet worth $7.5 million at a cost of $5.0 million in fiscal year 1982. If $3.9 million could be made available in fiscal year 1977, an additional 82.3 million cubic feet of insect-killed material worth $5.9 million could be salvaged. The recommended salvage program for fiscal years 1978-1982[7] can be summarized as:

Fiscal year	Volume (million cubic feet)	Cost (million dollars)	Receipts (million dollars)
1978	93.9	9.7	6.0
1979	103.9	7.7	7.1
1980	116.0	6.5	7.5
1981	122.0	6.2	7.5
1982	127.8	5.0	7.5
Total	536.6[8]	35.1	35.6

Because of the necessity of removing the constraints, such as the construction of access roads, prior to the removal of insect-killed material, the costs in the early years of the recommended program are high (fig. 1). However, by 1980 total annual receipts begin to significantly exceed total annual costs.

Since most of the areas will be regenerated naturally, few of the costs presented here include allowances for site preparation or planting. If this kind of treatment should be prescribed, additional funding would be needed.

The total cost figures for removing constraints do include such activities as the construction of minimum standard access roads and land-use planning. Since these activities are necessary prerequisites to the future management of these areas, these costs should be spread over the total resource management effort rather than attributed to the salvage activity alone.

In some situations where the costs of constructing system roads is prohibitive, the use of lower standard, temporary, or limited-use roads may be necessary to conduct a cost-effective salvage program. These opportunities should be explored fully before any management action is taken.

The National Forest Management Act of 1976

The National Forest Management Act of 1976 provides a mechanism for financing a portion of the needed salvage program on the National

[7]If $3.9 million could be made available in fiscal year 1977, an additional 82.3 million cubic feet of insect-killed material valued at $5.9 million could be salvaged.

[8]Of this amount only 385 million cubic feet are constrained.

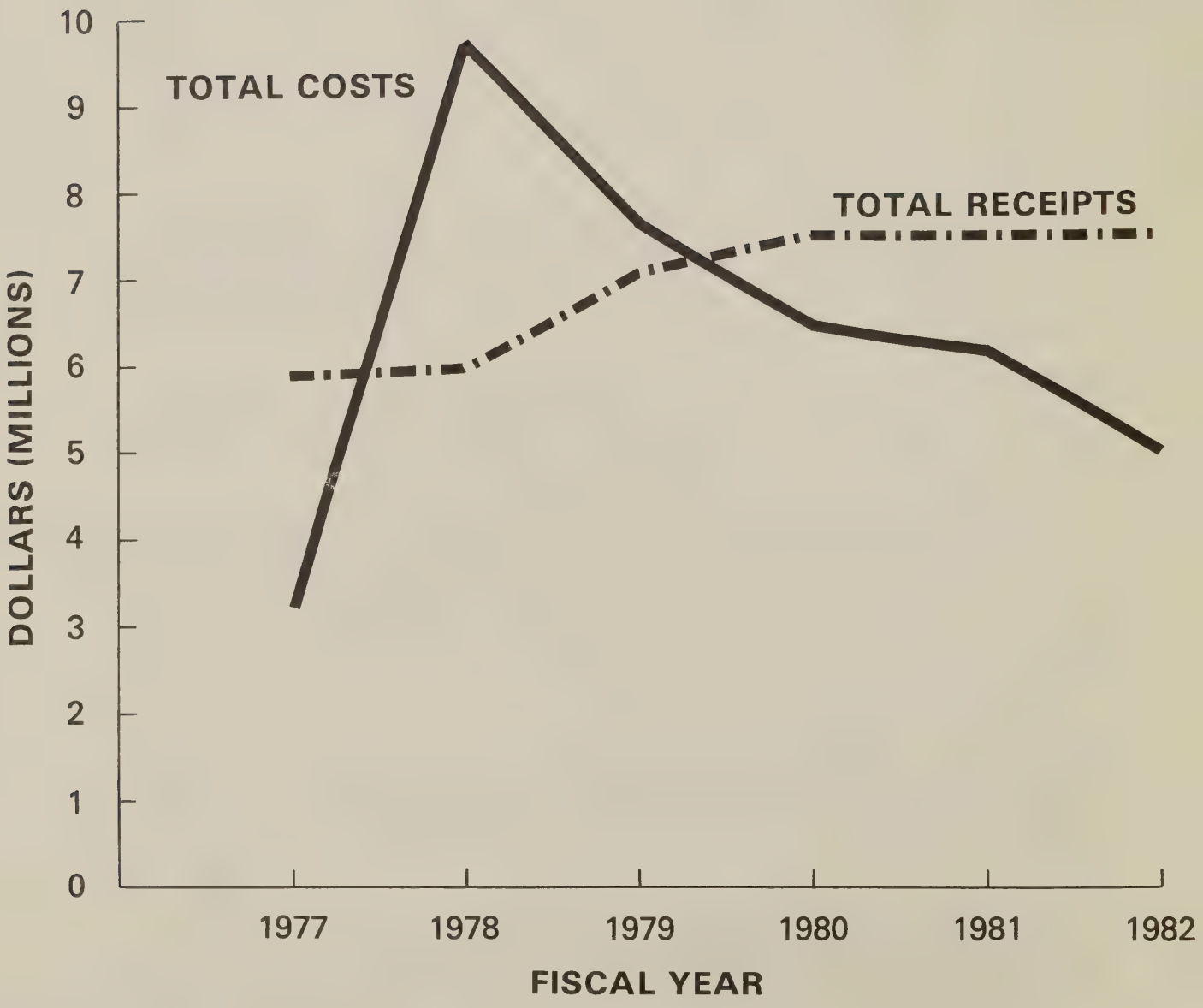

Figure 1. Relationship of total costs to total receipts by fiscal year for recommended salvage program.

Forests. Section 14(h) authorizes collection of funds to cover the cost of design, engineering, and supervision of roads needed for access to salvage sale areas and the cost for Forest Service sale preparation and supervision of the harvesting of insect-infested, dead, damaged, or down timber and associated trees for stand improvement.

The objective of the Salvage Sale Funds is to provide for the optimum practical use of wood material in situations involving salvage, including the promotion of more effective utilization of salvable wood material. To assist in obtaining optimum practical use of salvage wood material from National Forest lands, a Salvage Sale Fund will be established on each National Forest which has salvage opportunities. This will be a revolving fund financed from required deposits of purchasers from salvage sales. The amounts collected will be a part of the payment for salvable material and will be available until expended. The Salvage Sale Fund is not intended to replace, or to be used to accomplish, that part of the timber sale program financed by appropriated funds. Normally, dead and dying timber marketed with the fund will be in addition to the volume of timber to be sold financed by appropriated funds.

Since deposits of money will be made in this designated fund only as salvaged timber is harvested, no money is in it to finance the initial sales under this provision. However, since the fund does not cover road construction or road maintenance costs, the volume involved would be limited to sales with existing access until other funds are available to provide access.

The Salvage Sale Fund will only cover a portion of the cost where the value of salvable timber is less than the costs of preparation and administration. Since the deposits must be spent to meet the cost of the salvage sale on the National Forest where the sums were collected, some Forests will require appropriated funds to complete the job.

A preliminary investigation indicates that on some Forests, such as the Clearwater and Panhandle in Idaho and the Malheur and Umatilla in Oregon, the Salvage Sale Fund could finance the authorized work. However, the fund probably could not finance the same work on the Medicine Bow in Wyoming, the San Juan in Colorado, or the Targhee in Idaho.

Immature Stands

The Study Team believes the most important action needed to prevent intolerable losses caused by insects, primarily bark beetles, in the future is to provide the necessary silvicultural treatment to young stands to minimize their susceptibility to attack. To do this, the Forest Service should accelerate its current effort to provide the necessary silvicultural treatment to the 1.9 million acres of pole-size lodgepole and ponderosa pine stands growing on sites which produce 85 cubic feet or more per acre per year. This program should provide, as a minimum, for the construction of about 175 miles of

minimum standard access roads and the silvicultural treatment of about 64,000 acres of pole-size stands. This program would cost about $15.6 million annually and should be given priority consideration if we are going to avoid recreating the conditions that exist today in our mature and overmature stands which are being decimated by bark beetles.

Although the problems on nonindustrial private lands are not so serious as those on National Forest lands, about 181,000 acres of lodgepole and ponderosa pines growing on good sites should receive the necessary silvicultural treatments. To encourage this, these areas should be given high priority for the use of cost-sharing funds through the Forestry Incentives Program. For the States to develop and maintain a sufficient program to accomplish the job within a reasonable period of time, the allocation of Forestry Incentives Program funds to these States would have to be increased significantly. In areas where the use of the Forestry Incentives Program is not appropriate, emphasis should be placed on getting the job done through the technical assistance supplied under the Cooperative Forest Management Program.

The Forest Pest Control Act of 1947 provides another opportunity for accomplishing the job on nonindustrial private lands. This Act authorizes, among other things, the Federal Government to share the costs with States and others of measures designed to prevent losses caused by forest insects and diseases.

Regardless of landownership, all foresters working in the West whose jobs involve management planning or silvicultural prescriptions should be fully trained in the use of the latest available technology to minimize losses by insects. Private landowners should also be informed so that they can make better land management decisions and secure the necessary assistance through the appropriate people.

Research, Development, and Application

As a minimum the Study Team recommends a program to emphasize the development and application of currently available technology. This program should include pilot projects to evaluate insecticides and stand manipulation practices, damage survey and analysis, and the development and demonstration of harvesting and utilization technology. This program would cost about $2 million annually.

However, to prevent intolerable forest resource losses caused by forest insects in the future, this effort should be expanded, as soon as resources can be made available, to include a research, development, and application program for western bark beetles and to expand research on the establishment, management, and protection of young stands on the most productive sites. A program at this level would cost $5.3 million annually for a 5-year period.

Other Recommendations

Progress of this program should be reviewed in fiscal year 1979 and modified as necessary to meeting changing conditions.

The Timber Management and Forest Insect and Disease Management Staff Units should develop,by October 1977,a system to monitor losses caused by forest insects and diseases in the West in order to provide a sound basis for a continuing program to harvest pest-caused mortality and to provide followup treatment as necessary.

The Forest Service should continue its long-standing policy of giving high priority to the selection and cutting of those timber stands most urgently in need of silvicultural treatment, such as those that are deteriorating because of advanced age or damage from climatic factors, diseases, or insects.

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